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# WATER RESOURCES STUDY, FISHING RIVER BASIN, MISSOURI. STUDY OF POTENTIAL NEEDS AND VALUE OF WATER STORAGE FOR MUNICIPAL, INDUSTRIAL, AND QUALITY CONTROL PURPOSES

Federal Water Pollution Control Administration
Kansas City, Missouri

March 1964

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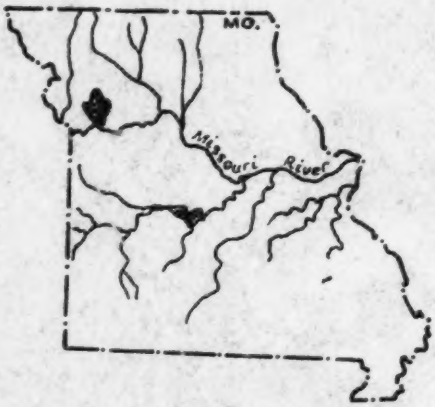
# WATER RESOURCES STUDY
# FISHING RIVER BASIN
# MISSOURI

## Study of Potential Needs and Value of Water Storage for Municipal, Industrial, and Quality Control Purposes

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**Kansas City, Missouri**

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# WATER RESOURCES STUDY

# FISHING RIVER BASIN

# MISSOURI

Prepared for

DEPARTMENT OF THE ARMY

U. S. Army Engineer District

Kansas City, Missouri

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VI
Kansas City, Missouri

MARCH 1964

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# I. INTRODUCTION

## Authority

In a letter dated August 1, 1963, the Kansas City District of the Corps of Engineers requested the Public Health Service to make an investigation of the present and prospective needs for municipal and industrial water supply and for the regulation of streamflow for water quality control in the Fishing River Basin.

This study has been made in accordance with the Memorandum of Agreement dated November 4, 1958, between the Department of the Army and the Department of Health, Education and Welfare, relative to the Water Supply Act of 1958 (Title III of Public Law 85-500) and the Federal Water Pollution Control Act of 1956, both as amended by P.L. 87-88.

## Purpose and Scope

The purpose of this study is to determine the need for and value of storage for municipal and industrial water supply and streamflow regulation for quality control in Clear Creek, in East Fork Fishing River, and in Fishing River, a tributary of the Missouri River.

The study covers municipal and industrial water needs and needs for streamflow regulation for quality control during the study period of 1960 to 2060. The study area is the Fishing River drainage basin located in parts of Clay, Clinton and Ray Counties in Missouri.

## Acknowledgments

The cooperation of the following Federal, State, and local agencies which were contacted for information and assistance is gratefully acknowledged:

1. U. S. Army Engineer District, Kansas City, Corps of Engineers.
2. U. S. Geological Survey, Surface Water Branch, Rolla, Missouri
3. Missouri Water Pollution Board, Jefferson City, Missouri.
4. Missouri Division of Health, Jefferson City, Missouri
5. Missouri Water Resources Board, Jefferson City, Missouri
6. Haskins, Sharp, and Ordelheide, Consulting Engineers, Kansas City, Missouri
7. City officials of Excelsior Springs, Missouri
8. City officials of Lawson, Missouri

# II. SUMMARY AND CONCLUSIONS

## Summary

1. The East Fork Reservoir is proposed for construction on East Fork Fishing River at Excelsior Springs. The Dry Fork Reservoir is proposed for construction on Dry Fork at Excelsior Springs. The Clear Creek Reservoir is proposed for construction on Clear Creek about 4 miles northwest of Kearney. East Fork Fishing River and Clear Creek are tributaries of the Fishing River, and Dry Fork is a tributary of East Fork Fishing River.

2. The study area is the Fishing River drainage basin, located in parts of Clay, Clinton, and Ray Counties in Missouri. For statistical interpretations, economic projections were made only for Clay County.

3. The area of the Fishing River Basin is approximately 282 square miles.

4. Population of the one-county study area was 87,474 in 1960, of which 70,654 was urban and 16,820 was rural.

5. Excelsior Springs with a 1960 population of 6,418, is the principal community in the drainage basin.

6. Average daily 1963 municipal and industrial water use of the communities studied in the basin was 0.86 mgd (million gallons per day) supplying a population of 8,150 people with an average use of approximately 105 gpcd (gallons per capita per day).

7. The raw wastes produced at Excelsior Springs are approximately 5,600 P.E. (population equivalents).

Conclusions

1. The urban population of the study area will increase from 70,654 persons in 1960 to 180,000 persons by 2010 and to 325,000 persons by the year 2060.

2. Municipal and industrial water demands for Excelsior Springs will increase from 0.75 mgd in 1960 to 1.8 mgd by 2010 and to 3.3 mgd by the year 2060.

3. Water storage in the two proposed reservoirs at Excelsior Springs could be used as a source of water to supply the municipal and industrial water needs for Excelsior Springs and Lawson.

4. The value of storage in the two proposed reservoirs at Excelsior Springs to meet the present and projected municipal and industrial water demands, which natural runoff does not supply, is $24,970 per year for the duration of the study period, 1960 to 2060. The year of first need is 1960.

5. Total streamflows needed for quality control at the main pollution point, Excelsior Springs' lagoon effluent to Fishing River, are shown in Table No. VIII-2. Based on 0.10 probability of flows being equal to or less than volumes indicated, i.e., 90 percent protection level, the streamflow regulation required for quality control is shown below:

| Year | Draft on Storage Required for Water Quality Control Acre-Feet/year |
|---|---|
| 1960 | 350 |
| 2010 | 1,320 |
| 2060 | 2,470 |

6. Maintenance of satisfactory water quality in the Fishing River Basin will benefit a wide spectrum of water uses in the study area. Recreational opportunities, including fishing, swimming, water skiing, and boating will be increased. The esthetic values of the stream stemming from clean surface waters and a satisfactory public health water environment will be restored and the restoration or preservation of property values in areas contiguous to the stream will thereby be assured. Practically all communities now have adequate waste treatment plants either in operation or under construction. If the proposed Clear Creek Reservoir is used for streamflow regulation for quality control, it will improve the water quality of Clear Creek for a distance of 11 miles and improve the quality of Fishing River for 22 miles. If the proposed reservoirs at Excelsior Springs are used for streamflow regulation for quality control, they will improve the water quality of East Fork Fishing River for 8 miles and improve the quality of Fishing River for 14 miles. The total population of the study area will benefit from streamflow regulation. The 1960 population of 87,474 is expected to increase to 180,000 persons by 2010 and 325,000 by 2060.

7. The total annual value of storage to supply the above streamflow regulation for quality control is $10,200 per year for the duration of the study period.

# III. DESCRIPTION OF PROJECT

## Location

The smaller of the two proposed reservoir sites near Excelsior Springs is on Dry Fork in Clay County while the larger reservoir is on East Fork Fishing River in Ray County. The proposed reservoir on Clear Creek is located about four miles northwest of Kearney in Clay County. The Fishing River Basin covers parts of Clay, Clinton, and Ray Counties.

## Streamflow

The only gaging station in the basin is located on East Fork Fishing River at Excelsior Springs, Missouri. During the 12 years of record (1950 - 1962) periods of no flow were reported at times in 1953-57, 1960, and 1962, with a maximum period of 75 consecutive days in 1953. The maximum discharge was 23,100 cfs and the average discharge during 12 years of record was 11.8 cfs. 11/

## Water Quality

No data are available on surface water quality in the Fishing River Basin. From studies made on the Platte River Basin and the Grand River Basin, it was assumed for the purpose of this report that mineral solids concentrations are not critical in the waters of the Fishing River. Table No. III-1 shows some representative quality data from the Platte River Basin and Grand River Basin.

Table No. III-1

Mineral Solids Concentrations in Two Basins Adjacent to the Fishing River Basin

Concentrations in Milligrams per Liter (mg/l)

| Constitutent | Platte River Basin | Grand River Basin |
|---|---|---|
| Dissolved Solids | 410 | 151 |
| Hardness ($CaCO_3$) | 226 | 78 |
| Chlorides (Cl) | 22 | 9 |
| Sulfates ($SO_4$) | 83 | 63 |
| Nitrates ($NO_3$) | < 0.1 | 0.9 |

Surface water quality data regarding its suitability for specific uses should be obtained prior to the development of final project plans.

Pertinent Data

As proposed, the two multiple-purpose reservoirs at Excelsior Springs will control a drainage area of approximately 23 square miles, and the proposed reservoir on Clear Creek will control a drainage area of approximately 29 square miles. Storage space data for the proposed reservoirs are shown below in acre-feet. 12/

| | Clear Creek | East Fork | Dry Fork |
|---|---|---|---|
| Flood Control | 16,500 | 16,000 | 2,300 |
| Conservation | 21,500 | 15,000 | 2,000 |
| TOTAL | 38,000 | 31,000 | 4,300 |

# IV. DESCRIPTION OF STUDY AREA

## Location and Boundaries

The study area is the Fishing River drainage basin located in parts of Clay, Clinton and Ray Counties in Missouri. It is approximately 282 square miles.

## Geography and Topography

The study area is bounded on the west by the Platte River Basin, on the north by the Grand River Basin, on the east by the Crooked River Basin, and on the south by the Missouri River. The lower portion of the basin, generally below Miltondale, Missouri (see map in Section IX) lies in the broad Missouri River flood plain. The topography of the rest of the basin is moderately hilly and the drainage has a dendritic pattern.

## Climate

Climate of the Fishing River Basin is characterized by hot summers and moderately cold winters. The average annual temperature in the basin is about 56° F, with extremes of 113° F and -22° F. The normal frost-free growing season in the basin is approximately 180 days.

The rainfall averages about 35 inches, but has varied between extremes of 21.5 and 50.2 inches. The basin is in the normal path of severe storms, illustrated by the record rainfall of 12 inches in 42 minutes at Holt, Missouri, in the northern part of the basin, on June 22, 1947. 13/

# V. ECONOMICS

## Present

For statistical interpretation, the study area for the economics investigation was defined as the entire County of Clay, Missouri.

The study area is a portion of the Kansas City Standard Metropolitan Statistical Area (SMSA) and is dependent primarily upon the service establishments (such as construction, transportation, communications, utilities, wholesale and retail trade) and manufacturing to support its economy. In 1960, the service establishments contained 70 percent or 24,610 persons of the total labor force (34,897). Manufacturing employment contained 23 percent or 8,156 persons of the total labor force. Table No. V-1 depicts employment data for the study area. 1/

Table No. V-1

The Number and Percent of the Labor Force 1/ by Major Subdivision

Fishing River Study Area

1940 - 1950 - 1960

| | 1940 | | 1950 | | 1960 | |
|---|---|---|---|---|---|---|
| | Number | Percent of Labor Force | Number | Percent of Labor Force | Number | Percent of Labor Force |
| Farm | 2,231 | 18.0 | 1,658 | 9.0 | 1,045 | 3.0 |
| Mining | 243 | 2.0 | 62 | 1.0 | 122 | 0.0 |
| Manufacturing | 1,835 | 15.0 | 4,297 | 24.0 | 8,156 | 23.0 |
| TOTAL BASIC | 4,309 | 35.0 | 6,017 | 34.0 | 9,323 | 26.0 |
| TOTAL SERVICE | 7,133 | 58.0 | 11,496 | 64.0 | 24,610 | 71.0 |
| UNEMPLOYED | 840 | 7.0 | 358 | 2.0 | 964 | 3.0 |
| TOTAL LABOR FORCE | 12,282 | 100.0 | 17,871 | 100.0 | 34,897 | 100.0 |
| POPULATION | 30,417 | | 45,221 | | 87,474 | |

Agricultural employment decreased from 1,658 in 1950 to 1,045 in 1960. During the period 1949 to 1959, the number of farms decreased from 1,713 to approximately 1,120. However, farm consolidation and increased technology brought about an increase in the value of farm products sold, as shown in Table No. V-2. 2/

Table No. V-2

Agricultural Trends 2/

Fishing River Study Area

1949 - 1959

| | No. Farms | Value of all Farm Products Sold* |
|---|---|---|
| 1949 | 1,713 | $11,560,182 |
| 1954 | 1,329 | 9,348,390 |
| 1959 | 1,120 | 14,029,654 |

*Adjusted to the 1959 value of the dollar.

Manufacturing employment has increased from 1,835 in 1940 to over 8,000 in 1960. Over 60 percent of the increase has been in the fabricating metal and food and kindred products categories. The number of establishments and value added by manufacturers has shown a significant increase. Refer to Table No. V-3. 3/

Table No. V-3

Manufacturing Trends 3/
Fishing River Study Area

| | No. Establishments | Value added ($1,000) by Manufacturers* |
|---|---|---|
| 1947 | 76 | $ 68,363 |
| 1954 | 103 | 114,022 |
| 1958 | 128 | 136,730 |

*Adjusted to the 1959 value of the dollar.

The minerals available in the study area are stone and coal. The dollar values of minerals produced ranged from the low of approximately $800 thousand in 1957 to the high of $ 2.0 million in 1961. Table No. V-4 depicts value of minerals extracted trend. 4/

Table No. V-4

Value of Minerals Extracted 4/

Fishing River Study Area

1952 - 1961 (million dollars)*

| | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 |
|---|---|---|---|---|---|---|---|---|---|---|
| Study Area | 1.0 | 0.9 | 1.4 | 1.3 | 1.0 | 0.8 | 1.0 | 1.3 | 1.1 | 2.0 |

*Adjusted to the 1959 value of the dollar.

The study area as part of the Kansas City Standard Metropolitan Statistical Area has shown a significant growth in population, increasing from 20,302 in 1910 to 87,474 in 1960. During this period, the rural portion of the study area increased from 13,422 to 16,820, while the urban portion increased from 6,880 to 70,654. Table No. V-5 shows population data. 5/

Table No. V-5

Population Data 5/

Fishing River Study Area

1910 - 1960

| | 1910 | 1920 | 1930 | 1940 | 1950 | 1960 |
|---|---|---|---|---|---|---|
| Urban | 6,880 | 7,262 | 10,655 | 11,150 | 28,244 | 70,654 |
| Rural | 13,422 | 13,193 | 16,156 | 19,267 | 16,977 | 16,820 |
| TOTAL | 20,302 | 20,455 | 26,811 | 30,417 | 45,221 | 87,474 |

Future

The study area (Clay County) as part of the Kansas City SMSA is expected to continue to have significant growth. The type of development in the study area should be mainly residential, commercial and some light industry. The primary place of employment for these residents should in Kansas City. Therefore, for the purpose of this report, this growth will be measured only in terms of population. The study area is expected to increase at the same rate of growth as the Kansas City SMSA and reach 180,000 by 2010 and 325,000 by 2070. (These population projections were based primarily on projections made by Federal and local agencies.) [6,15,16] These projections for Clay County should be considered entirely urban. Excelsior Springs and Lawson were the two communities used for the determination for water storage for municipal and industrial and quality control. These two communities were expected to increase in the same proportion as the study area. Table No. V-5 depicts population projections. [6]

Table No. V-6

Population Projections [6]

Fishing River Study Area

1960 - 2070

| | 1960 | 2010 | 2060 |
|---|---|---|---|
| Urban | 70,654 | 180,000 | 325,000 |
| Rural | 16,820 | --- | --- |
| TOTAL | 87,474 | 180,000 | 325,000 |

# VI. WATER RESOURCES

## Surface Water

The Fishing River watershed drains approximately 282 square miles. The only streamflow gaging station in the basin is on East Fork Fishing River at Excelsior Springs, Missouri. The drainage area above the gaging station is 20 square miles. The runoff pattern on East Fork was assumed typical for the complete basin. Estimates based on a study of seasonal runoff patterns at East Fork Fishing River gaging station at Excelsior Springs indicate that the following uncontrolled runoff in mgd with probabilities of flows being equal to or less than volumes indicated of two percent and ten percent could be expected under natural low flow conditions at Excelsior Springs.

Probability of Recurrence of 2%

| Period | mgd |
|---|---|
| Summer (May, June, July, August, September) | 1.3 |
| Spring & Fall (March, April, October) | 4.3 |
| Winter (November, December, January, February) | 0.7 |

Probability of Recurrence of 10%

| Period | mgd |
|---|---|
| Summer (May, June, July, August, September) | 1.5 |
| Spring & Fall (March, April, October) | 5.1 |
| Winter (November, December, January, February) | 0.8 |

No surface water quality data are available for this basin. From a comparison of Platte and Grand River Basins it was concluded that the mineral quality of the surface water in the Fishing River and its tributaries is satisfactory for use as municipal and industrial sources of supply.

Ground Water

Limited data are available on ground water in the Fishing River Basin. Most of the wells in the basin are in glacial drift. This till is relatively thin in the uplands. However, there may be buried valleys containing thick glacial outwash. The drift-filled valleys may, but generally do not, coincide with modern valleys. 14/ At Excelsior Springs, there is little or no ground water available. However, Excelsior Springs secures its water from wells about five miles south in the Missouri River bottom lands. These wells are good producers and if the well field is properly maintained and expanded it could supply Excelsior Springs with municipal and industrial water for the foreseeable future.

# VII. MUNICIPAL AND INDUSTRIAL WATER SUPPLY NEEDS

## Present

The four municipal water supply facilities in the Fishing River Basin serve approximately 8,150 persons with an average of 0.855 mgd (million gallons per day). The average use in the basin is about 105 gpcd (gallons per capita per day). Details of municipal demands are shown in Exhibit No. 1 of the Appendix.

Nearly all of the municipal water comes from wells in glacial deposits. This water has low chloride and sulfate concentrations but is hard and high in total dissolved solids. Also, at times high concentrations are noted. Typical chemical analyses of ground waters in the Fishing River Basin are shown in Exhibit No. 2 of the Appendix.

## Prospective

Investigations indicate that the municipalities that could feasibly obtain municipal and industrial water from the three proposed impoundments will be limited to the communities of Excelsior Springs and Lawson. Municipal and industrial requirements have been based on the projected needs of these two communities. The need for municipal and industrial water for Excelsior Springs from the proposed reservoirs is based on savings in costs during the study period. Lawson uses water from an impoundment, and the supply is limited. Lawson is upstream from the proposed reservoirs and will have to pump water used from the reservoir. The Kearney well water supply is adequate for the present and foreseeable future needs. Both Excelsior Springs and Lawson representatives have expressed an interest in obtaining water from

the proposed reservoirs.

There are no major water using industries present or projected in the Fishing River Basin. Table No. VII-1 shows the present and projected needs of the two communities.

Table No. VII-1

Future Water Needs for Municipal and Industrial Water Supply in Lawson, Excelsior Springs and Vicinity

Fishing River Study Area

| Year | Population Served | mgd |
|---|---|---|
| 1960 | 6,700 | 0.8 |
| 2010 | 13,100 | 1.9 |
| 2060 | 20.200 | 3.5 |

Table No. VII-2 shows a sample of monthly mean withdrawals in mgd required for municipal and industrial water supply. These are the withdrawals from the reservoirs if they are used solely by the two municipalities for their water supply.

Table No. VII-2

A Sample Distribution of Monthly Mean Withdrawals Needed for Municipal and Industrial Water Supply
(mgd)

Fishing River Study Area

| Month | Year 1960 | 2010 | 2060 |
|---|---|---|---|
| April | 0.6 | 1.5 | 2.8 |
| May | 0.8 | 2.0 | 3.6 |
| June | 0.8 | 1.8 | 3.3 |
| July | 0.9 | 2.1 | 3.8 |
| August | 1.0 | 2.3 | 4.3 |
| September | 1.1 | 2.6 | 4.9 |
| October | 0.9 | 2.1 | 3.2 |
| November | 0.8 | 2.0 | 3.6 |
| December | 0.8 | 2.0 | 3.7 |
| January | 0.6 | 1.5 | 2.8 |
| February | 0.6 | 1.4 | 2.5 |
| March | 0.6 | 1.5 | 2.8 |

Considering inflow to the two proposed reservoirs at Excelsior Springs (based on 0.02 probability of flows being equal to or less than volumes indicated, i.e, 98 percent protection level) a draft on storage above reservoir inflow of approximately 2,500 acre-feet per year will be needed by 2060, 1,080 acre-feet per year by 2010 and 310 acre-feet per year in 1960.

Value of Storage

The most feasible alternative for a municipal and industrial water supply for Excelsior Springs and Lawson would be an extension of existing well field south of Excelsior Springs. This would require additional wells, additional transmission lines, and repairs and enlargement of existing treatment plant. This value is the estimated annual cost to obtain water from the existing system less the annual cost of treating and transporting the water from the two proposed reservoirs at Excelsior Springs. The annual value of storage for municipal and industrial water supply is estimated to be $24,970 (refer to Exhibits No. 4 and 5).

# VIII. STREAMFLOW REGULATION FOR QUALITY CONTROL

## Present

Excelsior Springs and Kearney have oxidation lagoons and receive approximately 6,300 P.E. (population equivalents) per day. The efficiencies of these two lagoons are estimated to be 90 percent BOD removal. The municipality of Lawson has no sewage treatment plant and discharges its waste into East Fork Fishing River. There are no industries in the basin discharging large amounts of waste to the streams. Low concentrations of chlorides and sulfates in basins adjacent to the Fishing River Basin indicate that there is little or no inorganic pollution in the basin.

## Prospective

Future waste loadings in the Fishing River Basin have been estimated on the basis of population growth projections and on the projected increase in municipal water demands. The table below presents the main factors used in estimating the future pollution loads in the study area.

Table No. VIII-1

Waste Loading Projection Factors
Fishing River Study Area

| | 1960 | 2010 | 2060 |
|---|---|---|---|
| Municipal Water Demand (gpcd) | 100 | 140 | 170 |
| Municipal Return (percent) | 85 | 85 | 85 |
| Organic Load per Population Equivalent (ultimate first stage BOD) | 0.25 | 0.25 | 0.25 |
| BOD Removal Efficiency (percent) | 85 | 85 | 85 |

The pollutional effect of waste discharges on a receiving stream is a function of a number of variables. The main assumptions used in evaluating the need for quality control storage or regulation below the three proposed reservoirs in the Fishing River Basin are enumerated below:

1. Waste discharged to the stream will continue to be primarily organic in nature.

2. Specific mineral and/or organic toxicants will not be a significant problem.

3. Considering the needs for water and the cost of providing this water, it was decided that a degree of protection of 90 percent, represented by a 10 percent probability of flows being equal to or less than those provided for, would be reasonable in this area.

4. Maintenance of a minimum concentration of 5 mg/l dissolved oxygen will provide reasonable protection for fish and other aquatic life and is in accordance with the objectives of the Missouri Basin Engineering Health Council.

5. Quality control needs were based on three different periods. The summer period was assumed to be five months long and to have an average water temperature of 25° C. The winter period was assumed to be four months long and to have an average water temperature of 5° C. The spring and fall periods were assumed to be three months long and to have an average water temperature of 15° C.

The oxygen-sag method was used to determine the quality requirements at the point where Excelsior Springs oxidation lagoon effluent enters the Fishing River. The table below gives the flow required in the stream to meet the above quality requirements.

Table No. VIII-2

Minimum Streamflows for Quality Control
at Excelsior Springs Lagoon Effluent
(mgd)
Fishing River Study Area

| Year | Summer | Spring & Fall | Winter |
|---|---|---|---|
| 1960 | 5 | 1 | 1 |
| 2010 | 9 | 3 | 1 |
| 2060 | 14 | 5 | 3 |

The above table indicates total flow required including natural runoff. Exhibit No. 6 shows a sample distribution of monthly mean reservoir releases but is not an operating schedule. The values shown are total releases and may be supplied from a single reservoir or by a combination of releases from more than one reservoir.

Considering quality control needs, natural runoff, and municipal returns, Table No. VIII-3 lists the annual draft on storage need from one of the three proposed reservoirs or a total annual draft from all three.

Table No. VIII-3

Summary of Net Regulation Requirements for Quality Control
in Acre-feet Per Year With a 90% Protection Level

Fishing River Study Area

| Year | Regulation Acre-Feet Per Year |
|---|---|
| 1960 | 350 |
| 2010 | 1,320 |
| 2060 | 2,470 |

The flow regulation requirements for quality control in Table VIII-3 have been increased 20 percent to compensate for problems of synchronization of releases and needs and conveyance losses.

Benefits

If the proposed Clear Creek Reservoir is used for streamflow regulation for quality control, it will improve the water quality of Clear Creek for a distance of 11 miles and improve the quality of Fishing River for 22 miles. If the proposed reservoirs at Excelsior Springs are used for streamflow regulation for quality control, they will improve the water quality of East Fork Fishing River for 8 miles, improve the quality of Fishing River for 14 miles, and provide some quality improvement of the Missouri River below its confluence with the Fishing River. The total population of the study area will benefit from streamflow regulation. The 1960 population of 87,474 is expected to increase to 180,000 persons by 2010 and 325,000 by 2060.

Adequate streamflow regulation will improve fishing, recreation, esthetics, and agriculture, including stock watering from the reservoir to the mouth of the Fishing River. The streamflow regulation will prevent the impairment to health and welfare that results from inadequate streamflows. It is concluded, therefore, that benefits are widespread.

Value of Benefits

In 1960, the net annual regulation comes from one month need, the 2010 net regulation is two month's need, and the 2060 annual regulation is four month's need. The most feasible alternative for quality control storage would be a holding pond near Excelsior Springs' lagoons. The value of storage for quality control is assumed equal to the cost of a holding pond, lines from lagoon, and necessary valves. The pond should be large enough to hold the sewage for the months when there is not

enough natural streamflow to assimilate the waste and keep the dissolved oxygen level at at least 5 mg/l. In 2060, there will be approximately a four-month period when not all of the treated sewage from Excelsior Springs should be released into Fishing River. Using this detention time, the holding pond should have a capacity of approximately 46,000,000 cubic feet. The total cost would be approximately $250,000. There is a present need for this holding pond for about a one-month period.

An amortization period of 100 years and an interest rate of 4 percent were used for converting capital costs to equal annual costs. The annual value of storage for streamflow regulation for quality control is $10,200.

## IX. MAP OF AREA

# X. BIBLIOGRAPHY

# BIBLIOGRAPHY


1. U. S. Bureau of the Census, U. S. Census of Population: 1950 and 1960, Volume II, "Characteristics of the Population," U. S. Government Printing Office, Washington, D. C., 1952 and 1961.

2. U. S. Bureau of the Census, U. S. Census of Agriculture: 1949, 1954, 1959; Volume I, U. S. Government Printing Office, Washington, D. C., 1950, 1956, 1961.

3. U. S. Bureau of the Census, U. S. Census of Manufactures: 1954 and 1958, Volume III, "Area Statistics," U. S. Government Printing Office, Washington, D. C., 1956 and 1961.

4. U. S. Bureau of Mines, Minerals Yearbook: 1953, 1955, 1957, 1959, 1960, Volume III, "Area Reports" U. S. Government Printing Office, Washington, D. C.

5. U. S. Bureau of the Census, U. S. Census of Population: 1930, 1950, 1960, Volume I, "Number of Inhabitants," U. S. Government Printing Office, Washington, D. C.

6. Water Resources Activities in the United States, "Population Projections and Economic Assumptions," Committee Print No. 5, Select Committee on National Water Resources, U. S. Senate, Washington, D. C., 1960.

7. U. S. Geological Survey, Surface Water Supply of the United States: 1961, Part 6-B, U. S. Government Printing Office, Washington, D. C.

8. Kansas State Department of Health, Chemical Quality of Surface Waters in Kansas, 1957-1960, Compiled and Published by the Kansas State Board of Health, Division of Sanitation, Topeka, Kansas, 1960.

9. Department of the Army, Inclosure with Letter to Public Health Service, Division of Water Supply and Pollution Control, Region VI, dated October 29, 1963, Kansas City, Missouri.

10. Kansas Water Resources Board, Storage Requirements to Sustain Gross Reservoir Outflow, Part 4, 1962, Kansas State Printing Plant, Topeka, Kansas, 1962.

11. U.S. Geological Survey, Surface Water Records of Missouri: 1962 U.S. Government Printing Office, Washington, D.C.

12. Department of the Army, Inclosure with Letter to Public Health Service, Division of Water Supply and Pollution Control, Region VI, Dated August 1, 1963, Kansas City, Missouri

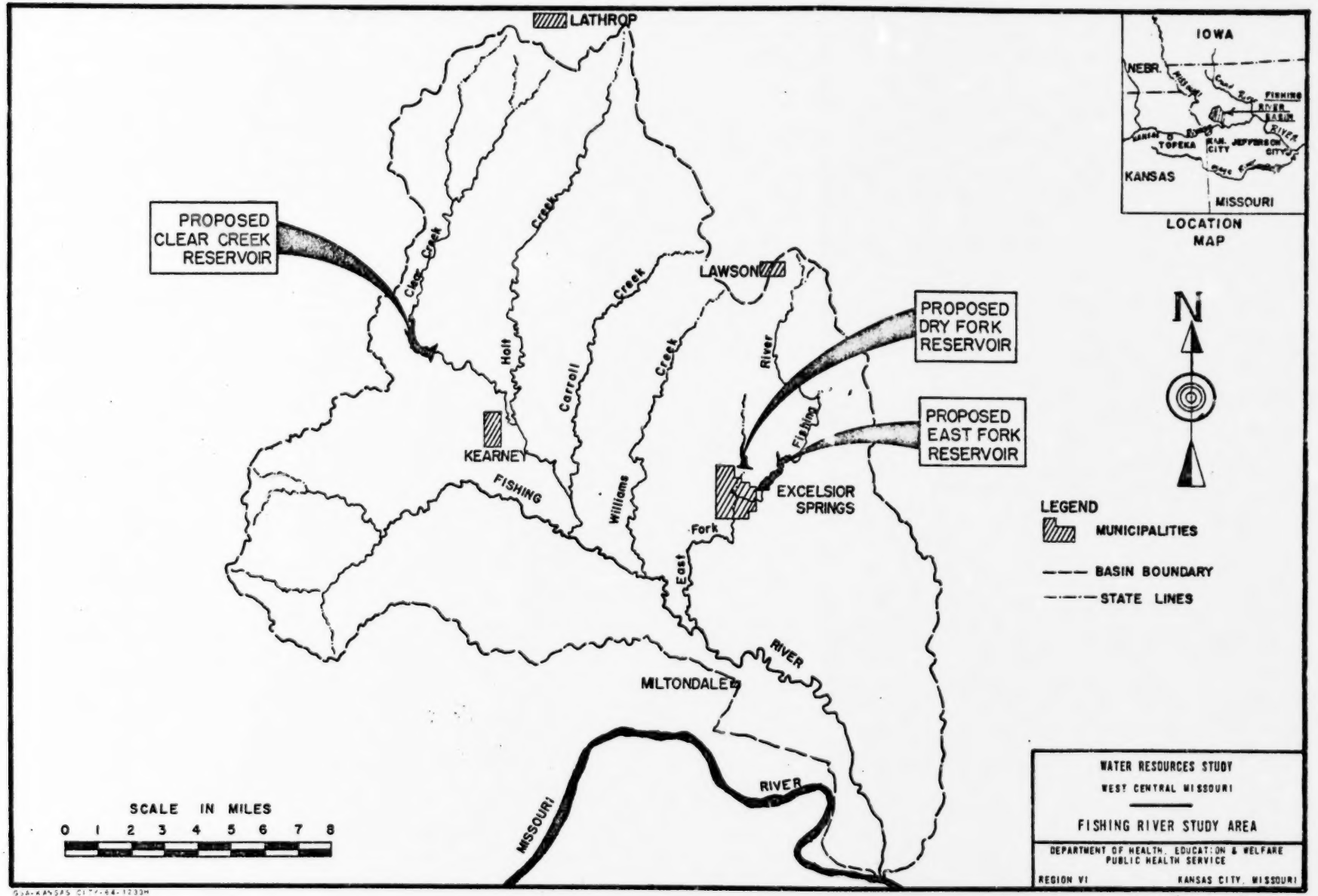
## BIBLIOGRAPHY (cont'd)

13. Department of the Army, Review of Report on Fishing River and Tributaries: 1956, Kansas City District, Corps of Engineers.

14. U.S. Geological Survey, The Role of Ground Water in the National Water Situation: 1963, C. L. McGuinness, Water Supply Paper 1800, U. S. Government Printing Office, Washington, D. C.

15. City Plan Commission, Population, Clay and Platte Counties, Kansas City, Missouri, 1955

16. City Plan Commission, Kansas City Metropolitan Area, Kansas City, Missouri, 1955


LATHROP
PROPOSED CLEAR CREEK RESERVOIR
Clear Creek
Holt Creek
Carroll Creek
LAWSON
Creek
River
PROPOSED DRY FORK RESERVOIR
PROPOSED EAST FORK RESERVOIR
Fishing
KEARNEY
FISHING
Williams
Fork
East
EXCELSIOR SPRINGS
MILTONDALE
RIVER
MISSOURI
RIVER
IOWA
NEBR.
KANSAS
MISSOURI
TOPEKA
JEFFERSON CITY
LOCATION MAP
N
LEGEND
MUNICIPALITIES
BASIN BOUNDARY
STATE LINES
SCALE IN MILES
0 1 2 3 4 5 6 7 8
WATER RESOURCES STUDY
WEST CENTRAL MISSOURI
FISHING RIVER STUDY AREA
DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VI
KANSAS CITY, MISSOURI

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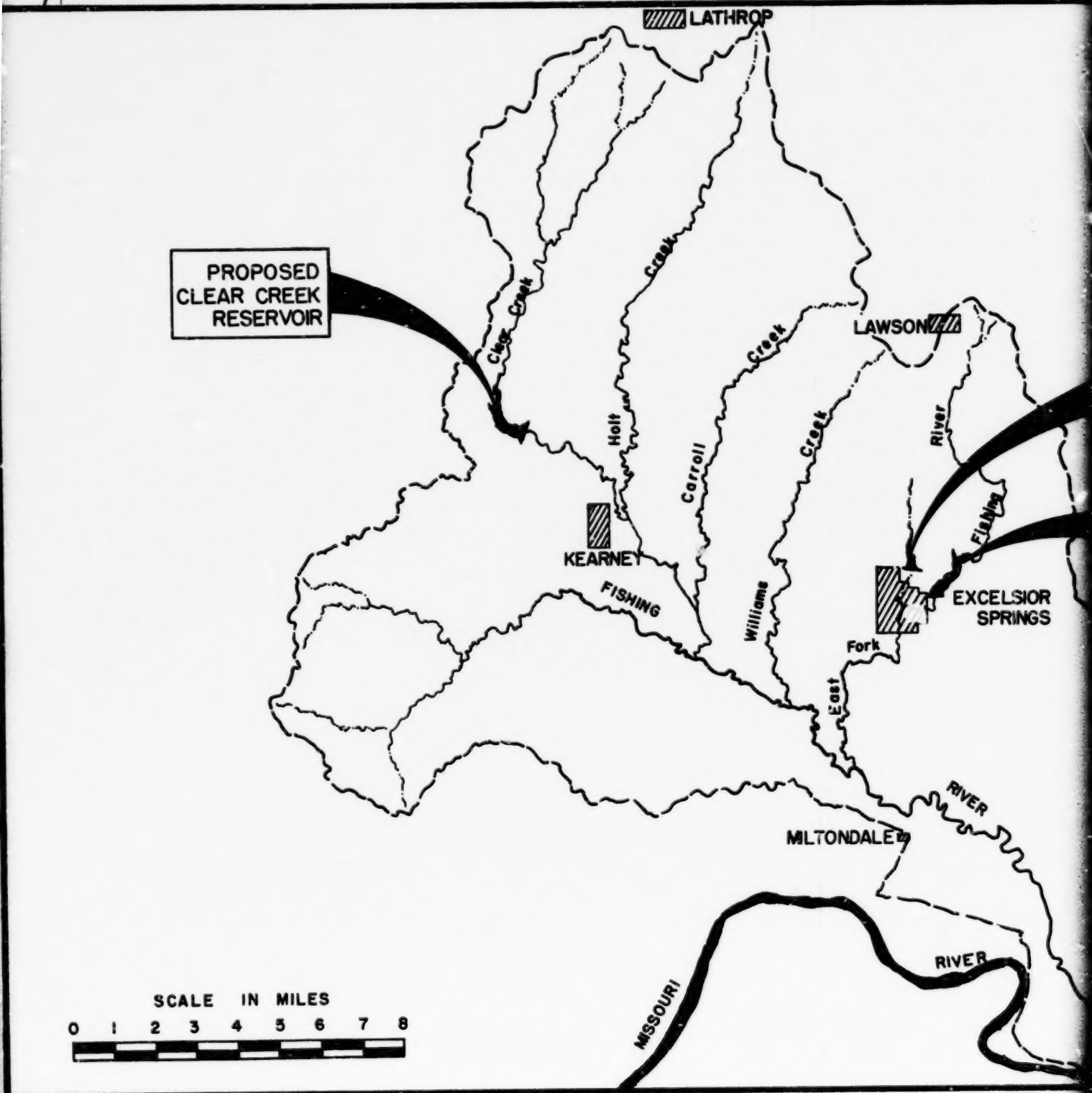


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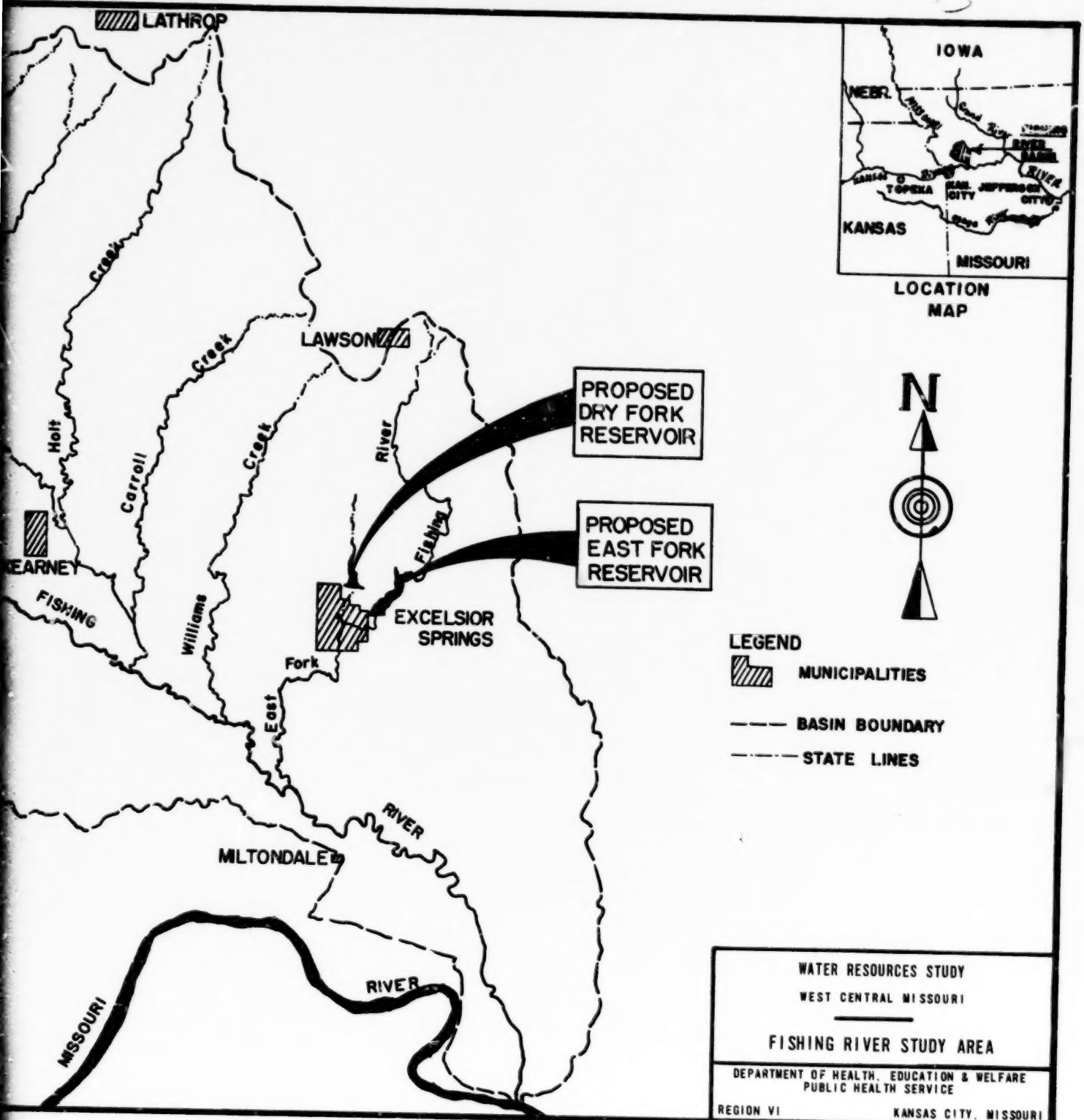
LATHROP
LAWSON
KEARNEY
EXCELSIOR SPRINGS
MILTONDALE
PROPOSED DRY FORK RESERVOIR
PROPOSED EAST FORK RESERVOIR
Holt Creek
Carroll Creek
Williams Creek
Fishing River
East Fork Fishing River
Missouri River
IOWA
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KANSAS CITY, MISSOURI

# XI. APPENDIX

Exhibit No. 1

Municipal Water Supplies

Fishing River Study Area

| Municipality | 1960 Population | 1963 Population Served | Water Treatment | Source of Supply | Maximum Dependable Draft (MGD) | Average Output (MGD) | GPCD |
|---|---|---|---|---|---|---|---|
| Excelsior Springs | 6,473 | 6,000 | Softening, Aeration, Chlorination | Wells (3) | 3.30 | 0.750 | 125 |
| Kearney | 678 | 700 | Purification, Aeration, Chlorination | Well (1) | 0.290 | 0.025 | 36 |
| Lawson | 778 | 700 | Purification, Aeration, Coagulation, Chlorination | Impoundment | 10.00* | 0.050 | 72 |
| Orrick | 800 | 750 | Aeration, Chlorination | Well (1) | 0.140 | 0.030 | 40 |
| | | 8,150 | | | | 0.855 | 105 |

*Safe yield impounded (MG)

Exhibit No. 2

Typical Chemical Analyses of Water Resources
(Results in Parts per Million)

Fishing River Study Area

| Location | Type* | Total Dissolved Solids | Chlorides ($Cl^-$) | Sulfates ($SO_4^=$) | Nitrate ($NO_3^-$) | Hardness ($CaCO_3$) | Iron (Fe) | Remarks |
|---|---|---|---|---|---|---|---|---|
| Excelsior Springs | M-T | 242 | 9 | 34 | 0.3 | 156 | 0.1 | Well - treated |
| Excelsior Springs | M-R | 436 | | 28 | 3.1 | 356 | 14.0 | Well #5 Aerator effluent |
| Kearney | M-T | 348 | 22 | 25 | 0.1 | 274 | 0.2 | Well - treated |
| Lawson | M-T | 415 | 30 | 100 | 0.1 | 242 | 0.02 | Impoundment Treated |
| Orrick | M-T | 530 | 18 | 68 | - | 356 | 1.4 | Well - treated |

* M - Municipal
  T - Treated water
  R - Raw Water

Exhibit No. 3

Basic Data on Sources of Pollution

Fishing River Study Area

| Municipality | River Miles Above Mouth | 1960 Population | 1963 Sewered Population | P.E.(BOD) Before Treatment | Nature of Wastes | Treatment Provided | P.E. (BOD) Discharged | Watercourse* |
|---|---|---|---|---|---|---|---|---|
| Excelsior Springs | 14E | 6,473 | 5,600 | 5,600E | Domestic | Oxidation Lagoons | 560E | Fishing River |
| Kearney ** | - | 678 | None | 678E | Domestic | Oxidation Lagoon | 68E | Clear Creek |
| Lawson *** | - | 778 | None | 810E | Domestic | Oxidation Lagoon | 81E | East Fork Fishing River |

E - Estimated

* - Watercourse that sewage plant effluent is either presently discharged to or expected to discharge to in the future.

** - The recently constructed Kearney Lagoon is expected to be in operation early in 1964.

*** - A contract for the construction of an oxidation lagoon for Lawson is expected to be let by January 1964.

Exhibit No. 4

## Cost of Construction, Repairs, and Equipment of Existing Water Supply System

### Fishing River Study Area

| Construction, Repairs or Equipment | Year of Need | Cost |
|---|---|---|
| 23,000 feet of 12" pipeline in place | Now | $248,000 |
| New post chlorinator, waterproof filter walls make filter controls operable and construct new flocculator | Now | 100,000 |
| New well | Now | 20,000 |
| Clean raw water line | Now | 12,000 |
| New well | 1980 | 20,000 |
| New low and high lift pumps | 1980 | 10,000 |
| Remove covers from and rework filters | 1980 | 100,000 |
| 23,000 feet of 20" pipeline in place | 2000 | 441,000 |
| 7,000 feet of 18" pipeline in place | 2000 | 113,000 |
| New well | 2000 | 20,000 |
| New high lift pump | 2000 | 6,000 |
| Major plant revisions | 2010 | |
| 1. 2 new 1.0 mgd filters | | 150,000 |
| 2. New clear well | | 50,000 |
| 3. Elevated backwash tank and two pumps | | 38,000 |
| 4. 2 new low lift pumps | | 8,000 |
| 5. New feeders, rework pipe gallery, rework sed. and flocculation basins, and new mixing equipment and basins | | 200,000 |
| New well | 2035 | 20,000 |
| New low and high lift pumps | 2035 | 10,000 |
| Rework Old filters | 2035 | 50,000 |

Exhibit No. 5

Annual Value* of Storage for Municipal and Industrial Water Supply Using Most Feasible Alternative

Fishing River Study Area

| | Using Existing System to Supply Water | | | Using Proposed Reservoirs at Excelsior Springs to Supply Water | | | |
|---|---|---|---|---|---|---|---|
| Year | Annual Operation and Maintenance | Capital Cost | Present Worth** | New Plant and Transmission Line | Repairs and Replacements | Annual Operation and Maintenance | Present Worth** |
| 1960 | | $380,000 | $380,000 | $400,000 | | | $400,000 |
| | 40 years @ $28,000 | | 647,220 | | | | |
| 1980 | | 130,000 | 71,980 | | | | |
| 2000 | | 580,000 | 177,830 | | | | |
| | 10 years @ $37,500 | | 98,070 | | | | |
| 2010 | | 446,000 | 101,730 | | $300,000 | | 68,430 |
| | | | | | | 100 years @ $23,500 | 742,570 |
| 2035 | | 80,000 | 8,710 | | | | |
| | 50 years @ $57,500 | | 337,460 | | | | |
| 2060 | | | | | | | |
| | | | $1,823,000 | | | | $1,211,000 |

Annual value of storage for municipal and industrial water supply = (1,823,000 - 1,211,000) X (0.040808***) = $24,970

*The annual value of storage is the annual cost of supplying water from the proposed project, subtracted from the annual cost of the most feasible alternative

**Discounted at 3% interest rate

***Amortized at 4% interest rate



Exhibit No. 5

Exhibit No. 6

A Sample Distribution of Total Monthly Mean Reservoir Releases Needed for Quality Control in MGD*

Fishing River Study Area

| Month | 1960 | 2010 | 2060 |
|---|---|---|---|
| April | 0 | 0 | 0 |
| May | 0 | 0 | 0 |
| June | 0 | 0 | 1 |
| July | 0 | 0 | 0 |
| August | 0 | 6 | 12 |
| September | 4 | 10 | 16 |
| October | 0 | 0 | 0 |
| November | 0 | 0 | 1 |
| December | 0 | 0 | 1 |
| January | 0 | 0 | 0 |
| February | 0 | 0 | 0 |
| March | 0 | 0 | 0 |

* Volumes contain 20 percent overage to cover such items as conveyance losses and atypical flow or quality conditions. This is not an operating scheme.